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NOTES ON THE NESTING HABITS OF SEVERAL NORTH AMERICAN BUMBLEBEES.[1]

By O. E. Plath.

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In a comprehensive paper on the bumblebees of Central Europe, Friese and Wagner (1910, p. 69) make the following statement: "Insbesondere lässt die Kenntniss der Nester noch allzuviel zu wünschen übrig, was um so empfindlicher ins Gewicht fällt, als gerade von dieser Seite her die vielleicht wertvollsten Aufschlüsse zu erwarten stehen, weil allen Folgerungen, die lediglich auf einem durch Fang der frei fliegenden Tiere gewonnenen Materiale basieren, notwendigerweise eine gewisse Unsicherheit anhaften muss." The truth of this statement has been amply proved by the work of Drewsen and Schiödte (1838), Smith (1876), Schmiedeknecht (1878), Hoffer (1881, 1882/83, 1885, 1888), Coville (1890), Sladen (1899, 1912, 1915), and Frison (1916, 1917, 1918, 1921).

What Friese and Wagner (p. 69) have to say concerning the Central European bumblebees, is even more true of our American species. Of the 86 New World species of Bremus (Bombus) listed by Franklin (1912/13, 1914) and Frison (1921a), the nesting habits of only 17 have thus far been recorded,[2] but some of these data are so incomplete that they have little or no value. It is the object of this paper to add another species (*Bremus occidentalis* Greene) to those enumerated below and to supplement our knowledge concerning the nesting habits of several others. A brief résumé of all that is known of the nesting habits of the 9 species treated in this paper has been added, in order to make these data as complete as possible. The new facts which I have recorded in the following paragraphs are based on observations of 55 bumblebee colonies which were discovered at Berkeley, Calif., Washington, Me., and Boston, Mass., during the summers of 1920, 1921, and 1922, and on copious field notes.

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[1] Contribution from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 211.

[2] Those of *Bremus affinis*, *auricomus*, *bimaculatus*, *borealis*, *cayennensis*, *emeliæ* (*thoracicus*), *fervidus*, *flavifrons*, *impatiens*, *pennsylvanicus*, *perplexus*, *rufocinctus*, *separatus*, *ternarius*, *terricola*, and *vagans*;by Putman (1865), Coville (1890), Hudson (1892), von Ihering 1903), Franklin (1912/13), Howard (1918), and Frison (1916, 1917, 1918, 1921).

The interesting beetles of the genus Antherophagus, and also mites of the family Gamasidæ, occurred in almost every one of the 50 nests which I examined, and in one case over 20 of the beetles were found; but, to avoid useless repetition, the individual cases are not cited below.

TERRESTRIS GROUP.

I. *Bremus affinis* Cresson.

Very little is known concerning the nesting habits of this bee. Some years ago, Franklin (1912/13, I, p. 280) found a nest in southern Vermont during the early part of July. It was situated in an open mowing place on the surface of the ground, and, since it contained but a few cells with partially developed larvæ, had apparently been started only shortly before by the queen. Franklin (p. 280) makes the following statement regarding the location of this nest: "Although this was a surface nest, the fact that the queens of this species are never seen in abundance, while the workers and males in late summer often appear in large numbers, together with the fact that their nests are so seldom found, leads me to the opinion that they are usually subterranean."

The surmise expressed in the forgoing quotation is confirmed by my own observations. Of 9 *Bremus affinis* nests discovered in the Arnold Arboretum (within the city limits of Boston) during the summers of 1921 and 1922, every one was subterranean. They were situated from 1 to 4 ft. below the surface of the ground and had tunnels varying from 18 inches to 8 ft. in length. The largest colony was taken on September 1, 1922. It contained the old queen, 19 young queens, 27 males, and over 175 workers.

Not long ago, Bequaert (1920) described a new variety of *Bremus affinis* which he called *novæ-angliæ*. This variety occurred in 2 of the 8 nests mentioned above. The first of these was taken July 11, 1922. It contained (1) the old queen, 1 young queen, and 43 workers of *Bremus affinis*; (2) 12 workers of *Bremus affinis* var. *novæ-angliæ*; and (3) 1 worker of *Bremus terricola* Kirby. The second nest was taken August 4, 1922. In it were found (1) 23 workers of *Bremus affinis*; (2) 9 workers of *Bremus affinis* var. *novæ-angliæ*; and (3) 1 worker of *Bremus terricola*. The contents of these two nests, and the character of the bees reared from the second, suggest that *Bremus affinis* var. *novæ-angliæ* Bequaert is a hybrid between *Bremus affinis* and *Bremus terricola*, a question which will be discussed in another paper.

Two other of the 8 *Bremus affinis* nests were victimized by *Psithyrus ashtoni* Cresson. One of these, on August 9, 1921, contained (1) the old queen and about 100 workers of *Bremus affinis*; and (2) the old queen, 3 young queens, and 6 males of *Psithyrus ashtoni*. A detailed account of the subsequent history of this *affinis-ashtoni* colony has appeared in another paper (1922). The second colony parasitized by *Psithyrus ashtoni* was taken on July 26, 1922. It contained (1) the old queen and about 20 workers of *Bremus affinis*; and (2) the old queen (dead), 2 young queens, and 2 males of *Psithyrus ashtoni*. During the following weeks several more young Psithyrus queens and males were obtained from this colony.

Bremus affinis frequently stores a considerable quantity of pollen in long, waxen cells, which Hoffer (1882/83, II. pp. 85, 86) called pollen cylinders. I noticed a number of these pollen cylinders in 2 of the 8 *Bremus affinis* colonies. Both of these colonies were rather large, each one having over 150 workers. In one of these two nests most of the pollen cylinders were from 5 to 6 cm. long, and the total pollen contained in them weighed about 2 ounces.

The queen of *Bremus affinis* is colored differently than the workers and males, and for a time it seemed doubtful whether the two groups belonged together (cf. Franklin 1912/13, I, p. 280). My observations confirm the conclusions of Bridwell and Franklin.

In the vicinity of Boston, the queens of *Bremus affinis* leave their winter quarters toward the end of April, and most colonies are probably started in May. The workers begin to appear toward the end of May, and the young queens and males are largely produced in August and September. The more prosperous nests do not break up until October.

Bremus affinis is gentle as compared with such species as *Bremus fervidus* and *Bremus impatiens*. When one disturbs their nest, the foraging workers, as a rule, immediately fly away as soon as they notice the intruder.

II. *Bremus occidentalis* Greene.

There seems to be no record (cf. Franklin 1912/13, I, p. 273) that a nest of *Bremus occidentalis* has ever been taken. I accidentally discovered 2 nests of this species at Berkeley, Calif. during the summer of 1920, both of which were subterranean. One of these was about 2 ft. below the surface of the ground, and contained (July 12th) 5 young queens and over 80 workers. This colony was transferred to an observation box, but soon afterwards was destroyed by Argentine ants (*Iridomyrmex humilis* Mayr). The other colony was not dug up.

Bremus occidentalis is similar in disposition to *Bremus affinis*.

III. *Bremus terricola* Kirby.

Practically nothing is known concerning the nesting habits of this species. Coville (1890) probably took a colony near Ithaca, N. Y. during the summer of 1885, but he only briefly refers to its egg-laying habits.

I took a nest of this species near the Arnold Arboretum on July 3, 1922, and about two weeks later another nest was taken by Dr. E. S. Anderson, at Washington, Me. The nest which I took was situated 9 inches below the surface of the ground with a tunnel 1 ft. long; the other, according to Dr. Anderson, was about 3 ft. below the surface, and had a tunnel 21 ft. long. The nest taken near the Arnold Arboretum contained (1) 9 young queens and about 60 workers of *Bremus terricola*; and (2) the well-preserved bodies of a *Bremus impatiens* and a Psithyrus queen belonging to the Laboriosus Group. In the other, Dr. Anderson found (1) the old queen and about 125 workers of *Bremus terricola:* and (2) numerous pseudo-scorpions.

In the vicinity of Boston, *Bremus terricola* is the first bumblebee to appear in spring. In 1922 several queens were seen on willow as early as April 13th. Most colonies are probably started between the 15th of April and the 15th of May. The workers begin to appear shortly after the middle of May, and most of the young queens and males are produced in July and August. I have never seen any workers after September 1st.

The workers of *Bremus terricola* are somewhat more vicious than those of *Bremus affinis*.

BOREALIS GROUP.

I. *Bremus borealis* Kirby.

Coville (1890, pp. 198,201) records taking a nest of this species in July 1885 near Ithaca, N. Y. It contained "the queen and a large number of workers," but nothing is said as to whether the nest was situated on, or below, the surface of the ground.

On July 8, 1922, I noticed a *Bremus borealis* queen searching for her nest among the mowed grass near a stump, about a mile from the Arnold Arboretum. She was carrying a big load of pollen and repeatedly arose into the air to take her bearings. Whenever she alighted, she hurriedly crept about among the grass, at times frantically shaking her wings. I removed all the cut grass within a radius of about 10 ft. of the stump, but even then she was unable to find her nest. Fearing that she might desert the place, I captured and used her for breeding experiments which will be described in a separate paper. Although I searched carefully near the stump, no surface nest could be found, and it is therefore probable that this nest was subterranean.

In the neighborhood of Boston, *Bremus borealis* is extremely rare. Most of the queens probably do not appear until late in spring. Three other queens which I captured in 1922 were taken May 29th (on Diervilla), June 6th (on Rhododendron), and July 2nd (searching for a nesting site). However I have never seen any workers or males of this species near Boston.

PRATORUM GROUP.

I. *Bremus bimaculatus* Cresson.

The only nest of *Bremus bimaculatus* of which we have a record was taken by Franklin (1912/13, I, p. 308) on July 15, 1904, at Bernardstown, Mass. It was situated on the surface of the ground, among the bases of saplings, in a thicket of alders, and contained 6 queens, 10 workers, 9 males and a considerable number of cells with partially developed larvæ.

I found 4 nests of this species in, or near, the Arnold Arboretum during the summers of 1921 and 1922. All were subterranean, and from 6 inches to 1 ft. below the surface of the ground, the tunnels varying from 9 inches to 4 ft. in length. One of the shorter-tunneled nests, taken July 3, 1921, was almost completely destroyed by the larvæ of the tachinid fly, *Brachycoma sarcophagina* Townsend (det. Mr. C. W. Johnson). This nest also contained several thief ants (*Solenopsis molesta* Say (det. Dr. G. C. Wheeler). The largest of the 4 nests contained (July 8, 1921) the old queen, 23 young queens, over 60 workers, and a considerable number of queen cells.

In the vicinity of Boston, the queens of *Bremus bimaculatus* appear at about the same time as those of *Bremus terricola*, *i. e.* during the latter half of April. Most colonies are probably started in May. Like *Bremus pratorum* in Europe, *Bremus bimaculatus* completes its life-cycle very early. The workers begin to appear in considerable numbers toward the end of May, while most of the young queens and males are produced in June and July. The nests break up in August.

Franklin (1912/13, I, p. 309) says that the workers of this species are "very waspish," a statement which is corroborated by my experiences.

II. *Bremus impatiens* Cresson.

Putnam (1865, p. 101) reports taking a nest of this species under an old stump, in an orchard, but gives no further details, while Franklin (1912/13, I, p. 313) has the following to say con-, cerning the nesting habits of this bumblebee: "I have taken several nests of this species and have known of their being taken by others and, as far as I have been able to ascertain, they are invariably subterranean and the colonies often consist of a very large number of individuals." On August 31, 1904, the same author took a nest of *Bremus impatiens*, at Amherst, Mass. It was about 2½ ft. below the surface of the ground and contained 4 queens, 15 males, 321 workers, and 330 unbroken cells, 154 of which were queen cells.

I took 16 nests of this species during the summers of 1921 and 1922. Of these 16 nests, 11 were discovered in, and 5 near, the Arnold Arboretum, one of the latter being taken on the grounds of the Bussey Institution. All of these 16 nests, as well as several others which were not dug up, were subterranean. They were from 1 to 3 ft. below the surface, and had tunnels varying from 18 inches to 5 ft. in length. A number of these nests were situated in decayed stumps. Most of the colonies were very populous, the largest one consisting of over 450 workers (August 4, 1921). Five of the nests taken during the early part of the summer contained, in addition to the queen which "ruled" the nest, from 1 to 4 dead *impatiens* queens.

One of the 16 colonies was parasitized by a Psithyrus belonging to the Laboriosus Group. This nest, on August 8, 1922, contained (1) 17 males and about 75 workers of *Bremus impatiens*, as well as the well-preserved body of the old queen; and (2) the old queen and 2 males of Psithyrus. During the next few weeks, a considerable number of Bremus and Psithyrus males, and several Psithyrus females, were reared from this Bremus-Psithyrus colony.

Another of the 16 nests which was taken on September 11, 1922, contained (1) 31 males and about 50 workers of *Bremus impatiens*; (2) many adults and larvæ of Antherophagus; (3) a large number of spiny, dipterous larvæ (probably those of Fannia); and (4) numerous pseudo-scorpions (*Chelanops sanborni* Hagen (det. Mr. Nathan Banks). A few of these pseudo-scorpions were also found in one of the *affinis* nests. Mr. Nathan Banks has informed me that *Chelanops sanborni* is frequently found attached to the appendages of insects, especially those of Diptera. This fact, together with the fact that all 3 nests in which these pseudo-scorpions occurred, were at least 3 ft. below the surface of the ground, and had exceptionally long tunnels, suggests that Chelanops, like the beetles of the genus Antherophagus, gets into bumblebee nests by phoresy (cf. Wheeler, 1919).

Franklin (1912/13, I, p. 313) states that in the large nest of *Bremus impatiens* taken by him, the majority of the cells seemed to be entirely separate from one another. This was the case with most of the 8 *Bremus affinis* nests which I took, but it was not true of any of the 16 *impatiens* nests.

In addition to the main tunnel, which was about 1¼ inches in diameter, 3 of the most populous nests also had a narrower tunnel, about ½ inch in diameter, leading to the nest from the side opposite the main tunnel. Through this narrow tunnel, probably made by the bees themselves, nesting material was dragged in. In Europe, Wagner (1907, p. 11) found a similar narrow, secondary tunnel in connection with a nest of *Bremus lapidarius*, and concluded that it was constructed by the queen. However it seems more likely that this passage, if made by the bees, is excavated by the workers, and that it probably also serves as a ventilating shaft, for *Bremus lapidarius*, like *Bremus impatiens*, frequently has very populous colonies.

A prosperous *Bremus impatiens* colony stores a considerable quantity of honey and pollen. The latter, as in the case of *Bremus affinis*, is sometimes stored in pollen cylinders.

In the vicinity of Boston, the queens of *Bremus impatiens* appear in large numbers in May, and most colonies are probably started between the middle of May and the middle of June. The workers begin to appear about the first week of June, and the majority of the young queens and males hatch in August and September. The workers may be seen foraging as late as October.

Bremus impatiens is one of the more vicious species.

III. *Bremus vagans* Smith.

A nest of this species was discovered by Putnam (1865, p. 98) in 1862 at Warwick, Mass., but it is not clear from his description, whether it was situated in an old stump or under a pile of stones. A nest taken by Beutenmüller (cf. Franklin, 1912/13, I, p. 354), at Potato Knob, North Carolina (elevation 6,420 ft.), about July 1, 1902, was situated in a hollow tree, and contained 2 queens and 8 workers, but several individuals escaped. A third nest, taken by Franklin (1912/13, I, p. 354) July 20, 1904, on the surface of the ground, contained 2 queens, 2 males, and 8 workers.

I took 6 nests of this species in, or near, the Arnold Arboretum during the summers of 1921 and 1922. Two of these were surface nests, while the remaining 4 were subterranean. The latter were all about a foot below the surface of the ground and had tunnels varying from 1 to 5 ft. in length. The largest nest contained (August 2, 1921) the old queen, over 70 workers, and a considerable quantity of brood. This colony, as has been stated in another paper (1922), was later victimized by a Psithyrus.

In addition to the nest just mentioned, 2 others were parasitized by Psithyri. One of these was taken June 26, 1922. It contained (1) the old queen and about 40 workers of *Bremus vagans*; and (2) a Psithyrus queen belonging to the Laboriosus Group. The other, taken July 20, 1922, consisted of (1) the old queen and 6 workers of *Bremus vagans*; and (2) a Psithyrus queen belonging to the Laborisous Group. From one of these two colonies a considerable number of Psithyrus males and several Psithyrus females were reared which are different from those obtained from the *Bremus impatiens* nest referred to above.

The taxonomic position of these Psithyri will be dealt with in another paper.

In the vicinity of Boston, the queens of *Bremus vagans* appear comparatively late. In 1922, the first ones were seen on May 15th, on barberry and apple blossoms. Most nests are probably started between the 15th of May and the 15th of June. The workers begin to appear about the 1st of June, while the young queens and males are produced chiefly during August. The colonies break up in September.

Franklin (1912/13, I, pp. 348, 354) states that *Bremus vagans* is exceedingly ferocious, and that the workers of the nest taken by him were the most vicious and ready to sting of any with which he has had experience. This was not true of the 6 colonies taken by me, the workers of all of these colonies being rather gentle as compared with those of such species as *Bremus fervidus* and *Bremus impatiens*.

DUMOUCHELI GROUP.

I. *Bremus fervidus* Fabricius.

Both Putnam (1865) and Franklin (1912/13, I, p. 393) have taken a large number of nests belonging to this species. Putnam found them on the surface of the ground, under boards, piles of stones, the flooring of a shed, and in stumps, while the nests taken by Franklin were all surface nests. The largest nest taken by Putnam (July 23, 1863, at Bridport, Vt.) contained about 70 adult bees, 150 cocoons, and 200 larvæ. Of the two largest colonies reported by Franklin, one, taken July 22nd, consisted of 1 queen, 2 males, 30 workers, and 125 unbroken cells; the other, taken September 7th, 7 queens, 3 males, and 37 workers.

I took 13 nests of this species in, or near, the Arnold Arboretum during the summers 1921 and 1922, one of the nests being situated on the grounds of the Bussey Institution. Another nest of this species was taken (August 1922) at Washington, Me., by Dr. E. S. Anderson, who was kind enough to turn the colony over to me for observation. Of these 14 nests, 1 was situated 2 ft. above ground, in a stone wall, 4 were surface nests, and the remaining 9 were subterranean. These latter were from ½ to 1 ft. below the surface of the ground and had tunnels varying from ½ to 2 ft. in length. As in the case of *Bremus impatiens,* several of the nests taken during the early part of the summer contained one or more dead *fervidus* queens besides the one iving.

Franklin (1912/13, I, p. 393) states that the nests of *Bremus fervidus* never contain a large number of bees, the largest nest taken by him consisting of 47 individuals, of which 37 were workers. However this is not always the case. Of the 13 nests which I took, 3 consisted of from 100 to 125 workers each, and this despite the fact that one of them was taken comparatively early in the season (July 18, 1922). Each one of these 3 colonies ater produced more workers and more than a hundred males and young queens.

Of the 14 nests, one contained 22 large, dipterous larvæ which, judging by Sladen's (1912, p. 74) figure, were probably hose of Volucella. Attempts to rear the larvæ proved unuccessful.

When the first large *Bremus fervidus* nest was discovered during the summer of 1921, I at first thought I was dealing with a surface nest, for a large quantity of nesting material which conained about a dozen workers, covered the opening of the tunnel. This was also the case with 2 populous, subterranean nests of his species which I took during the summer of 1922. In Europe, Hoffer (1882/83, II, pp. 35, 36), Härter (1890, p. 74), and Bachmann (1915, p. 76), each found a similar "Vornest" or Scheinnest" in connection with the nests of *Bremus pomorum.* The only plausible explanation for these "pseudo-nests" seems o be that more nesting material is gathered by the colony than he nest cavity can hold.

In the vicinity of Boston, the queens of *Bremus fervidus* ppear in large numbers during the latter half of May. In 1922 he first one was seen on May 7th. Most nests are probably arted between the middle of May and the middle of June.

The workers begin to appear about the 1st of June, while th males and young queens are chiefly produced in August an September. The colonies, like those of *Bremus impatiens*, d not break up until October.

On page 99, Putnam (1865) makes the following statemen concerning *Bremus fervidus:* "This......species......is o quite a gentle disposition, allowing its nests to be disturbed fo some time before it makes any show of resistance, merely exhibiting its uneasiness by buzzing." I cannot subscribe to thi statement. Of all the species with which I have had experience— including *Bremus terrestris, lapidarius, agrorum, muscorum* *sylvarum*, and *helferanus* in Europe—, *Bremus fervidus* is b far the most vicious. Usually, when its nests are disturbe one or more workers at once pounce on the intruder and punis him. If he takes to his heels, they sometimes follow him for hundred yards or more. I was stung severely by this species o several occasions.

Bremus fervidus, as I have pointed out recently (1922a), ha the interesting habit of expelling the queens and workers of othe Bremidæ from its nests by daubing them with honey.

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THE MATING OF DIACAMMA[1]

By W. M. Wheeler and J. W. Chapman.

Diacamma is a very clearly defined genus of Ponerine ants confined to India, Ceylon, Southern China, the Malay Archipelago, New Guinea and the northeast corner of Australia. The species were carefully monographed by Emery in 1897, and a list of those known in 1911 was published by the same author in the "Genera Insectorum". There are only thirteen species, but one of them, the Indomalayan *rugosum* has some 25 subspecies and varieties. All the species have large black or bronzy, more rarely beautifully metallic blue or green, workers (Fig. 1), and pale yellow or yellowish red males (Fig.2), with very long antennæ and the pygidium terminating in a curved spine.

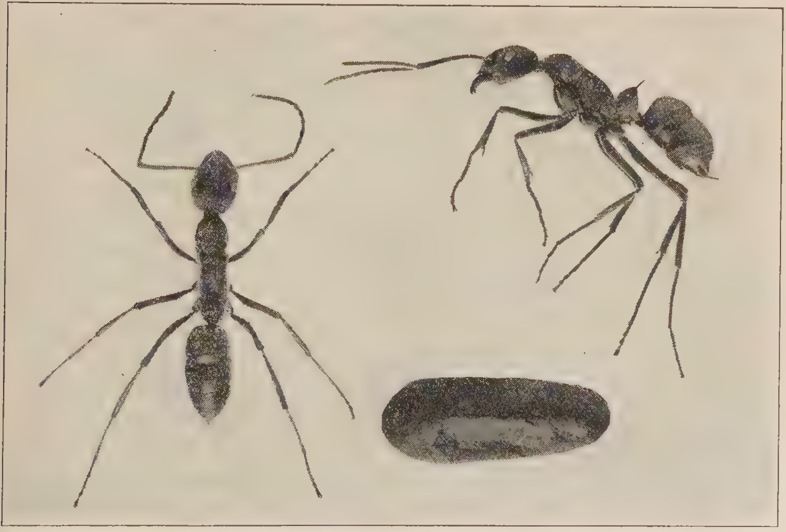

Fig. 1. Worker of *Diacamma australe*, dorsal and lateral view and black cocoon of same x4.

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[1] Contribution from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 212.

old logs or dead, standing tree-trunks and fills any chinks or openings with vegetable detritus.[1] The colonies are small, comprising, when fully developed, scarcely more than 50 workers and a dozen males. The workers are rather circumspect and cowardly and the males tend to fly out of the nest as soon as it is opened. The latter, like the males of Leptogenys and the Dorylines, are frequently taken at lights. On April 14, 1922 a nest of *geometricum*, situated under the loose bark of a large knot at the base of a standing tree trunk, was investigated and found to contain an average colony of workers with some eight males, a number of young and full grown larvæ and a few cocoons, which, as the senior author has shown (1915b) for this and other species of the genus, are dark brown or black. One of the males was copulating with a worker and as the pair failed to separate even after preservation in alcohol, we have been able to secure the accompanying photograph and drawing (Figs. 3 & 4). The fact that the wings of the male had been gnawed away at their

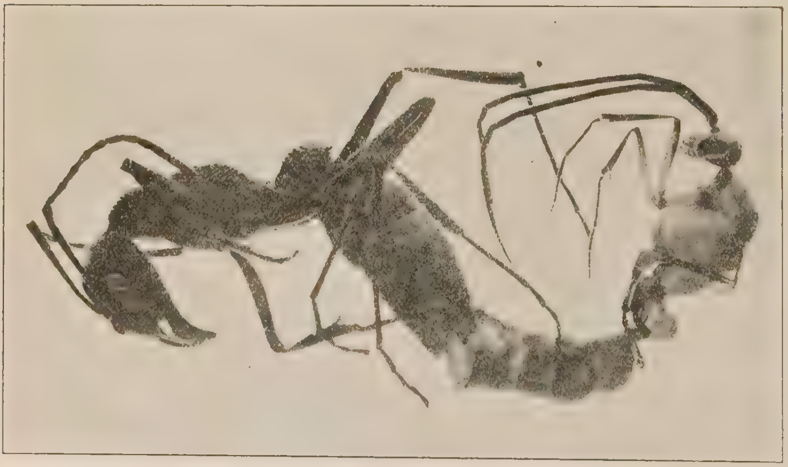

Fig. 3. Fertile worker and male of *Diacamma rugosum geometricum* in copula, from the left side x5.

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[1] Nearly all the nests contain a number of small cylindrical vegetable bodies, which prove to be the joints of the flower panicle of a peculiar grass (Rottboellia).' These joints, each of which contains a seed, are scattered by the plant, collected by the ants and stored in their nests. It would seem, therefore, that *D. geometricum* is to some extent vegetarian.

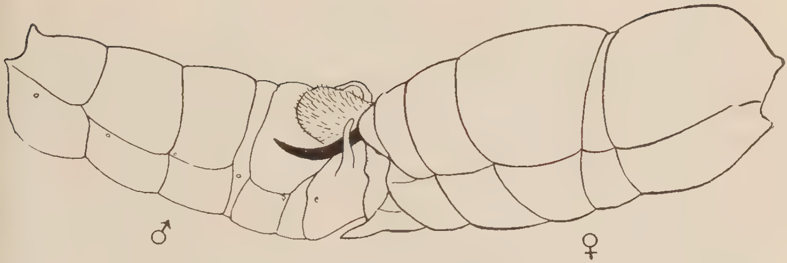

Fig. 4. Gasters of worker and male *Diacamma rugosum geometricum* from the right side x7.

bases suggests that the workers may thus prevent the escape of members of the opposite sex from the nest. The same mutilation is also practised on the males of Eciton, as noticed by W. Müller (1886) and the senior author (1921, p. 312). And since the other males taken in the same Diacamma nest were not deälated, it would seem that the workers do not mate with the males of their own colony, that is with their sons or brothers (adelphogamy), but with males that have come from other colonies. The very long sensitive antennæ of these insects, so like those of the Ichneumons, may enable them the more easily to seek out alien colonies of their own species. The small size of the Diacamma colony, moreover, indicates that only a single worker is fecundated and assumes the role of a queen, for if several or all of the workers laid fertilized eggs the colonies should be much more populous.

Externally the worker found *in copula* differs neither in size nor in structure from any of her sisters. Examination of the materials in the senior author's collection shows that both in *rugosum* and its varieties and in the various other species of the genus all the workers taken from the same colony are singularly uniform in size and structure, even to the minute details of sculpture and pilosity. As will be seen from Fig. 4. which shows the gasters of the mating individuals from the right side, the male and female genital orifices are in broad and very intimate contact. The powerful sting of the female is extruded and is held down by the finger-shaped process of the right external genital valve of the male.

Dissection of a number of Diacamma workers and especially of the mating worker supports the inference that only one individual in a colony assumes the reproductive function at a time. Unfortunately the material had been in rather weak alcohol for several months and the very hard chitinous integument of the gaster had prevented penetration, so that the internal organs were considerably decomposed. In many of the workers, of which more than 20, belonging to three colonies, were dissected, no ovaries could be detected. In one, however, two ovarioles were clearly seen, each of the type figured by Miss Holliday (1903, Fig. Ab, p. 295) for the ergatoid queen of *Lobopelta elongata*, i.e. with a large number of very small ova separated by clusters of nurse-cells. Such undeveloped ovaries were probably present in all the specimens but could not be detected on account of defective preservation. This may also explain our inability to find a spermatheca in any of these individuals. Fortunately the mating worker was in a somewhat better state of preservation. The ovaries were found very far forward, in the large first gastric segment and applied to the sides of the crop. There were five ovarioles in each ovary and the lowermost egg in each ovariole was fully developed and of an elongate-oblong shape, as in some other Ponerinæ (Pachycondyla, Lobopelta). The vagina and a large spermatheca attached to its dorsal wall were filled almost to bursting with compact masses of spermatozoa.

For some time evidence has been accumulating to show that Diacamma is not the only ant genus in which the winged queen has been lost and her function in the colony usurped by a fertile worker. The senior author, in the paper above mentioned (1915b, p. 337), called attention to the fact that winged females do not exist in the Ponerine genus Rhytidoponera, which is represented by a number of species in the Australian and Papuan Regions. The same condition very probably obtains also in the South African Streblognathus and Ophthalmopone and in the Neotropical Dinoponera, all genera belonging to the same subtribe as Diacamma (Pachycondylini). He also stated in his monograph of the Australian honey-ants of the Dolichoderine genus Leptomyrmex (1915a, p. 260) that true queens are in all probability absent in this genus and "that there are in each colony one or more fertile workers which supply the eggs that delevop into workers and males." And Arnold (1916, p. 195) says of a species of the South African genus Ocymyrmex, which belongs to the subfamily Myrmicinæ: "I have frequently dug up the nests of the variety *arnoldi* [of *O. weitzaeckeri* Emery] without ever having found a female of any sort, nor have females of any species been described up to now. I believe that the genus will be found to have only ergatoid queens, or that the egg-laying function (with the production of males and females) is possessed by the whole worker caste."

The fertile workers of Diacamma which function as queens are obviously not to be confused with two other types of wingless females, the ergatoid, or ergatomorphic queens and the dichthadiigynes.[1] Ergatoid queens are of rather frequent occurrence, either as the only form of fertile female or coexisting in the same species with winged queens, in one genus of Pseudomyrminæ (Viticicola), in at least one genus of Formicinæ (Polyergus), in several Myrmicine genera (Monomorium, Myrmecina, Leptothorax, Crematogaster, Harpagoxenus, etc.) and especially among the Ponerinæ (Eusphinctus, Cerapachys, Acanthostichus, Acanthoponera, Paranomopone, Alfaria, Megaponera, Ponera, Onychomyrmex, Leptogenys, Anochetus and Champsomyrmex).

In some cases (Leptogenys, Paranomopone, Megaponera and Eusphinctus) the queens differ very little from the workers, except in having traces of ocelli, a somewhat thinner petiole or a larger abdomen; in others the thorax is more complicated in structure and approaches that of the winged queen, while in still others (Acanthostichus, Onychomyrmex, Nothosphinctus) there is an approach to the dichthadiigyne, which is the only queen in all the genera of Dorylinæ, a characteristic form with very simple thorax, without eyes or with minute vestiges of eyes and ocelli and with a huge abdomen. Most of the ergatoid forms may be derived from the typical winged queen through a loss of the wings and a progressive, degenerative simplification of other characters, but it is conceivable that the dichthadiigynes may have arisen from fertile workers like those of Diacamma after complete phylogenetic suppression of the winged queen. The latter supposition will have to be tested by thorough morphological study of all the available fertile female forms.

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[1] A fourth form of female, the pseunogyne, is not discussed because it is pathological and does not function as a reproductive caste.

The conditions in Diacamma are suggestive also from another point of view. It has long been known that well-fed worker ants may lay eggs, but no one has ever seen a male copulating with a worker, and only Reichenbach, Mrs. Comstock and Crawley have found that eggs laid by workers may develop into workers. All other authors (Miss Fielde, Janet, etc.) maintain that such eggs invariably produce males. In *Diacamma geometricum* we actually have an ant whose workers copulate with the males and must therefore produce worker as well as male offspring, since there is no morphologically differentiated queen. Further studies of tropical ants in the field will probably compel us to to abandon certain other generalizations which we have reached from a too exclusive study of temperate European and North American species confined in artificial nests.

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NOTES ON THE FEEDING HABITS OF SCORPION-FLIES (MECOPTERA: PANORPIDAE).

By Waro Nakahara,

New York City.

The classical theory that adult Panorpids, or scorpion-flies, are predatory has no basis in fact. I refer to the observations of Felt(Tenth Report, N.Y. State, Entom pp. 463-480, 1893), in America, of Campion (The Entomologist, Vol. xlv, p. 322, 1912 in England, and of Miyake (Journ. Coll. Agric. Tokyo, Vol. iv, pp. 117-139, 1912), in Japan, all of which tend to establish that these interesting creatures feed upon dead animal matter, but never prey upon the living. Moreover, Miyake noted that *Panorpa klugi* M'Lach., which he studied in captivity sometimes feeds upon flowers, causing the petals to drop. Later, he(Ibid, pp. 265-400, 1913) reported observing in the fields "many scorpion-flies (*P. klugi*) swarming about a shrub and eagerly sucking its juicy fruits."

In connection with these observations, I wish to put on record here, that two species of scorpion-flies common in the vicinity of Ithaca, N. Y., namely *Panorpa rufescens* Ramb. and and *P. maculosa* Hagen will in captivity feed upon raspberries, strawberries, cherries, sliced bananas and apples, just as readily as upon dead wasps, house flies, caterpillars, spiders, etc. A few specimens were kept in a glass jar, containg a little moist earth in the bottom, and care was taken to provide them with dead insects along with the fruits. The scorpion-flies showed apparently an equally keen appetite for the animal and plant food. These observations, made in the summer of 1920, and again in 1922, taken together with Miyake's reports mentioned above, seem to show conclusively that adult Panorpids are mixed eaters, and that they cannot be called carnivorous as is commonly done in text-books.

A few words may be said regarding the method of feeding. Anatomically, because of the biting type of the mouth-parts, scorpion-flies may seem to be biting insects. By carefully observing many individuals during their feeding, however, it occurred to me that they must be regarded primarily as sucking insects, rather than as biting ones. They were often seen practically motionless with their long "beaks" deeply inserted in their food substances. When they feed on insects, they first bite a hole through the chitinous skin, and then appear to suck the body fluid. It would seem probable that the long rostrum provided with biting mouth-parts at the end, so characteristic of this group of insects, is an adaptive developed in relation to these interesting feeding habits.

It may not be amiss to add, in conclusion, that the excreta of the scorpion-flies under consideration are always of liquid nature, as might be expected if they were sucking insects. In no case was there observed any solid or semisolid excrement, such as that of a biting insect.

NOTES ON THE GIPSY MOTH IN MY UNSPRAYED WOODS AT EAST MARION, MASS.

1922.

By Fred C. Bowditch, Brookline, Mass.

The Gipsy has been increasing in numbers for the last two seasons and I judged that this year would be the high-water mark of their infestation. My woods near the house include a grove of oaks (largely white) and another group of oaks and white pine, and various detached oaks between.

The caterpillars have the habit before pupating of bunching together, sometimes in great numbers along the trunk of the tree or under a branch. They spin a slight web and pupate in more or less of a loose mass; others in numbers of up to, say, ten or twelve, curl up in the leaves, or their remains, rather tending to keep at the ends of the branches, drawing the parts together in a loose bunch.

About the middle of June the caterpillars were very plenty and the trees began to look thin. The Calosomas (green) were seen running on the trees though I did not see any attacks by them on the caterpillars (as observed in previous years); about the end of June the caterpillars were beginning to bunch up and I noticed at once Calosoma larvae working on them. These nearly always operated on some bunch of caretpillars on or near the trunk. The larvae were very voracious, eating constantly and increasing rapidly in size, their preference, if any, seemed to be caterpillars hunched up ready to become pupæ, because then they are perfectly helpless, almost torpid, still they constantly attacked the caterpillars and sucked out the pupæ. One small larva fastened into the rear of a full grown ♀ caterpillar, the latter threshed about, but the larva with his legs bent up held on tght and finally the caterpillar, still threshing, began to crawl rapidly up the tree, then juice began to drop from the body of the larva. He had got his head into the caterpillar, the latter stopped and the liquid ran down the larva. Next morning the caterpillar was a dry skin.

Various diptera attended the caterpillar bunches; only one, however, was actually observed to attack. This was a grayish fly somewhat larger than the domestic, and noticeably grayish on the upper side. The fly hovered over the caterpillars, lit on one and deposited a small white object, which I could see wiggle. Calling my man, who happened to be near by, we saw this little wiggler disappear into the body of the caterpillar at about his anterior third. This caterpillar I boxed to get the fly, but the caterpillar died of wilt. In addition to the insect enemies, the caterpillars were attacked by some form of "wilt" disease, which developed tremendously when they began to bunch up. For several days I had under observation one particular bunch of about seventy-five caterpillars, mostly large females. The disease would first show in a distending of parts of the body which gradually became semi-shiny, then the vitality would seem to go out of the caterpillar, his entire viscera would become putrid, and breaking open drop out, leaving the remains hanging. This bunch of seventy-five was kept at about the same size for some days by fresh additions. Not one spun a web and only once was a Calosoma observed. They all died of disease. Just after the first of July we had the bunches of caterpillars, with the various enemies and disease, all working together making what my wife called"a stinking mess". Then occurred a three days storm and these messes were in spots a good deal broken up and washed down. Most of the caterpillars had pupated and the Calosoma seemed largely to have disappeared (I found one dead, quarter grown) though some of the larger still showed, sucking pupæ which they continued to do until the moths began to emerge about July 10th. By this time a great bulk of caterpillars and pupæ along the trunks etc. had been killed, the former showing partly as old skins and the latter as sucked and broken shells, but there still remained thousands to hatch, especially in the leafy bunches at the ends of the branches; with this hatching arrived our friends the birds. Our oaks were alive with them, robins gulping down some whole and gathering bunches in their mouths and carrying them off to their nests, kingbirds swooping down and picking a male fluttering near the ground as well as attending to the tops; several kinds of vireos, chickadees, various kinds of sparrows and small birds, and last but by no means least, a family of five young blackbirds with their parents. The young were very amusing . They kept up a continual chatter, following up the old birds and begging for grub, jostling each other and always all day long on the go. It would seem that the position of a blackbird parent was no sinecure. For two or three days this bird-fest kept up. It was a rare thing thing to see a male gipsy on the wing. The females on the trunks were not molested nearly as much, perhaps because they were perfectly quiet, but the fluttering males, were everywhere gobbled up. As soon as the main moth emergence was over most of the birds faded away and only a few remained to pick up stragglers.

The females begin to lay eggs almost at once. On all egg clusters that I have examined under the moth and before she has dropped off are to be seen the egg parasite, (the imported Japanese) the imago of which emerges this Fall, and which leaves the egg cluster looking like a small pepper pot with its numerous holes.

Thus in unsprayed timber we have the various insect enemies, the "wilt" or whatever the disease is, the birds devouring imagoes and the egg parasite. I look for a distinct betterment in the outlook for 1923.

SOME PARASITIC HYMENOPTERA FROM NEW ZEALAND.[1]

By Charles T. Brues.

Dr. R. J. Tillyard, Chief of the Biological Department of the Cawthron Institute for Scientific Research in Nelson, New Zealand, recently sent me a small shipment of parasitic Hymenoptera for indentification. Although the collection consists of only a few specimens, these are of considerable interest on account of our almost complete ignorance of the insect fauna of New Zealand belonging to these families, and I have therefore taken this occasion to report upon them, although Dr. Tillyard has promised more extensive material in the future.

All the species mentioned below are apterous or nearly so, distributed in three families, the Ichneumonidæ, Braconidæ and Belytidæ. The types are in the collections of the Cawthron Institute.

Family Braconidae.

Metaspathius gen. nov.

♀ Apterous. Head globular; antennæ inserted on a frontal prominence, 17-jointed, scape short and thick, pedicel moniliform; first three flagellar joints much elongated; eyes very small, round; ocelli obsolete; head margined behind; clypeus excavated, leaving a rounded mouth opening; palpi simple; slender. Prothorax elongate; mesonotum without furrows; scutellum small, narrow, shield-shaped; propodeum coarsely reticulated. Legs with the femora much thickened; tibial spurs very small. Abdomen petiolate, the petiole three times as long as broad at apex which is twice as wide as the base, spiracles at the basal fourth, projecting laterally as tubercles; sides of petiole not continuous with the sides of the gaster. Ovipostor slightly longer than the abdomen.

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[1] Contribution from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 214.

Type. *M. apterus* sp. nov.

This genus differs from all other Spathiinæ known to me in the the form of the antennæ which have only 17 joints, the basal flagellar joints elongated and the antennæ are not attenuate toward the tips. Otherwise its characters are so typically those of this group that it could not be placed elsewhere. Kieffer[1] has described a genus, Folchinia, from the mediterranean region which may be related, but unfortunately he gives no characters which allow of its being placed in any subfamily.

I have a second species which is probably congeneric, but the antennæ are broken off near the base. It was sent me some years ago by Dr. Hans Brauns, collected at Bothaville, Cape Colony.

Metaspathius apterus sp. nov.

♀. Length 2mm. Fusco-ferruginous, the gaster and tips of antennæ piceous. Head above smooth and shining, highly convex and broadly rounded on the sides, with the eyes placed very far forward; above the eyes on the front are a few horizontal striæ and the very small ocellar space is indicated by minute hyaline points. Frontal projection like that of Belytid, as broad as the width of the eye. Face shagreened, clypeus shining; palpi yellowish white, slender. Eyes very small, nearly circular, bare, no wider than the thickness of the antennal scape. Scape two and one half times as as long, as thick, pedicel small, globular; first flagellar joint as long as the width of the head; more than six times as long as thick; second and third each three fourths as long as the preceeding, following growing shorter, but each more than twice as long as thick; tip of flagellum as thick as the base. Prothorax above as long as the mesonotum, reticulate. Mesonotum areolate, but without parapsidal furrows.

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[1] Ann. Soc. Sci. Bruxelles, vol. 30, pt. 2, p. 11 (1905)

Propodeum convex above, reticulate or irregularly areolate; perpendicularly delcivous behind. Pleuræ shagreened, the underside of the thorax clothed with long whitish hair. Petiole of abdomen coarsely shagreened and with four longitudinal carinæ, two above and one on each side at the level of the spiracle. Gaster smooth and highly polished, ovate, the second segment occupying more than one-half of the surface, before the tip with a transverse line of widely separated white hairs; following segments each with a similar line of hairs.

Type from Nelson, New Zealand, December 8, 1921 (A. Philpott).

At first glance this insect looks very much like a species of Pezomachus.

FAMILY ICHNEUMONIDÆ.

Pezomachus (*Gelis*) *philpottii* sp. nov.

♀ Length 2 mm. Mesonotum, legs, second and third abdominal segments, except sides, pale brownish yellow; head and pleuæ black; antennæ, except extreme base, petiole, and the sides and apex of abdomen piceous. Head twice as broad as thick, deeply excavated behind with the temples very strongly oblique; eyes very large; seen from above, extending nearly to the hind margin and highly convex; malar space as long as the width of the mandible, with a distinct furrow; face delicately shagreened, clypeus small, protuberant. Antennæ 23-jointed, slightly longer than the body, slender, especially at the base. Ocelli in a small triangle, the posterior ones equidistant from one another and the eye. Thorax rather strongly bilobed, the scutellum faintly indicated but not distinctly separated. Propodeum shining, with a faint tooth at the upper hind angle. Pleuræ smooth and polished. Petiole gradually and evenly widened behind, the sides straight with no indication of spiracular teeth; apex twice as wide as base; upper surface, seen from the side evenly convex,not angled near tip. Second and following segments smooth, sub-shining. Ovipositor projecting a distance equalling the length of the petiole. Legs unusually long and slender, the middle and hind coxæ large and swollen.

Type from Aniseed V., New Zealand, March 23, 1922 (A. Philpott).

This species resembles closely certain palæarctic and nearctic species of this highly polymorphic and no doubt also polyphyletic genus. It will be readily recognized by the black head and pleuræ and the very pale legs and mesonotum

FAMILY SCELIONIDÆ

Hoplogryon novæ-zealandiæ sp. nov.

♀. Length 1.0. mm. Head, abdomen and antennæ, except extreme base of scape black; legs, including coxæ, pale fuscous or yellowish brown, the tips of the tarsi blackened; thorax above, and on the pleuræ below, dark fuscous or piceous, the pleuræ yellowish brown above; mandibles, except tips, and extreme base of antennal scape yellowish. Entire body clothed with conspicuous pale hairs. Head, seen from above, twice as wide as thick, the ocelli in a rather low triangle, the lateral ones as far from the eye margin as from one another. Front smooth and polished above, with median line from the ocellus to the base of the antennæ; vertically striate below to the base of the mandible; cheeks, temples and occiput shagreened, vertex more strongly so. Antennal scape, funicle and club each of about equal length, the latter 6-jointed; scape slender; pedicel two-thirds as long as the first flagellar joint which is one-half longer than wide; second the same size as the first; third and fourth very small, moniliform; first club-joint quadrate, the following, except the last, each distinctly transverse. Mesonotum reticulately rugulose; parapsidal furrows indicated behind, but very indistinct anteriorly; scutellum more finely sculptured, nearly smooth behind; postcutellar spine short, acute. Lateral teeth of propodeum large, blunt at tips. Propleura with a large impression, areolate by very coarse raised lines; mesopleura deeply impressed below, irregularly horizontally wrinkled above. Wings short, extending to the tip of the second abdominal segment. Abdomen one-half wider than the thorax, almost globose; first segment as long as the width at base, apex twice as wide, coarsely longitudinally striate above; second segment twice as long as the first; coarsely striate, except at apex, which is smooth and shining; third segment very convex, delicately shagreened, as long as wide, broadest behind the middle, almost twice as long as the first and second together; fourth and fifth very short, sixth minute, occupying a median emargination of the fifth.

Type from Mt. Arthur (4000 ft.) New Zealand (A. Philpott).

This is the first member of this widely distributed genus to be found in New Zealand. It is similar to the European *H. pleuralis* Kieffer said to be probably from England, but differs by the longer striæ on the second abdominal segment and by the presence of the median frontal line. Among the species known from Australia, several of which have the thorax somewhat similarly colored, it may be known by the smooth third abdominal segment and different conformation of the antennal joints.

Paragryon castaneus sp. nov.

♀. Apterous; length 2 mm. Reddish brown, the antennæ and legs, including coxæ, more nearly fulvous; pleuræ piceous. Abdomen, especially beyond the second segment, thinly clothed with sparse, appressed, golden yellow hairs. The hairs, due to differences in direction, form more or less curved or sinuous patches which reflect light differently in relation to the source of illumination and give a peculiar mottled appearance. Head one-third broader than the thorax; twice as wide as long; temples rounded; occiput broadly emarginate and strongly margined; ocelci widely separated, the lateral ones separated by only their own diameter from the eye-margin; eyes pubescent, ovate; malar space as long as the width of the eye; head more or less irregularly longitudinally striate above; front smooth medially above the antennæ and vertically striate-punctate at the sides; cheeks with striæ converging toward the base of the mandibles, head behind coarsely and rather closely punctate. Antennæ 12-jointed; club 6-jointed; funicle and club of equal length, scape a little longer, reaching the vertex; scape slender; pedicel twice as long as thick; first flagellar joint longer than the pedicel, three times as long as thick; second, third and fourth decreasing in length, the fourth quadrate; club-joints about equal in length except, for the longer apical joint, the second to fifth about twice as broad as long. Thorax above rugose-striate, irregularly so on the mesonotum and longitudinally so on the scutellum; tegulæ present, but wings entirely absent. Propodeum deeply emarginate medially to receive the elevated base of the first abdominal segment, faintly toothed at the sides of the emargination and at the posterior angles. Pleuræ shining; striate below, in front and along the sutures; smooth elsewhere. Abdomen above shining; first segment rugose, second and third rugose-striate, the lines more or less longitudinal; fourth segment closely punctate; fifth confluently so; first segment as broad as long; second twice as long as the first, the width at apex greater than the length; third as long as the first and second together; distinctly broader than long; fourth to sixth decreasing in length, the fourth half as long as the third and equaling the apical ones together. Legs quite stout; tibial spurs very weak; tarsal claws simple.

Type from Mt. Arthur, New Zealand (A. Philpott) December 26, 1921, taken at an altitude of 4000 ft.

This species resembles *P. gracilipennis* Dodd,from Australia, in the elongated first flagellar joint, but differs in the configuration of the other antennal joints, and is wingless.

FAMILY BELYTIDÆ

In 1889, Cameron described from Greymouth, New Zealand, the genus Betyla, and in 1892 Marshall proposed the genus Tanyzonus for a Belytid reared from the larvæ of the remarkable New Zealand glow-worm, Bolitophila. Later in the same year, however, Marshall regarded Tanyzonus as synonomous with Betyla, believing the type species of both genera to be identical. In the material sent by Dr. Tillyard there are a number of specimens of Betyla-like insects representing three distinct genera; one of these is evidently Cameron's Betyla, while the second and third are undescribed. In view of the fact that there are several closely related genera and species present in New

Zealand, it must remain for the present somewhat doubtful whether *Tanyzonus bolitophilæ* Marshall and *Betyla fulva* Cameron are identical. Concerning this point, I cannot satisfy myself from Marshall's description.

The three genera may be distinguished by the following key, which includes also the related Neobetyla Dodd of which I have a specimen kindly sent me by Mr. Dodd.

Females.

1. Petiole of abdomen bearing a large tooth below; scutellum absent. *Betyla* Cameron
   Petiole of abdomen simple below; scutellum present . . 2.
2. Antennæ 13-jointed; wings present, much abbreviated, attaining the tip of the propodeum . . . . *Probetyla* gen. nov.
   Antennæ 15-jointed; wings entirely wanting. . . . . .3.
3. Propodeum with three spines, one at the middle above and one at each side behind the middle; pronotum along the median line, as long as the mesonotum. . . . .*Parabetyla* gen.nov.
   Propodeum without spines; pronotum visible from above only at the sides . . . . *Neobetyla* Dodd.

There are two specimens which are probably Cameron's *B. fulva*, taken by Mr. Philpott on Dun Mt. .,March 15, 1921 at an altitude of 2000 feet.

Probetyla gen. nov.

Antennæ 13-jointed, the club slender, not clearly differentiated, although the last six joints of the flagellum are thicker and moniliform; first flagellar joint longer than the pedicel, simple. Head seen from above quadrate, the temples broad. Eyes small, round, hairy. Maxillary palpi 5-jointed; labial palpi 3-jointed; left mandible with two long teeth; right one broader and probably with three teeth. Ocelli small, hyaline, in a small triangle. Thorax two-thirds as wide as the head, not constricted behind the mesothorax. Pronotum scarcely visible from above medially; parapsidal furrows present; scutellum with two foveæ at the base. Propodeum densely hairy, without spines; wings reaching to the base of the abdomen, strap-shaped. Petiole one-half longer than thick; second segment occupying most of the abdomen, following very short, the last not elongated nor compressed. Legs very slender, femora and tibiæ clavate. Body thinly clothed with erect, long, glistening pale hairs as well as with more dense pile on the prothorax and abdominal petiole.

Type: *P. subaptera* sp. nov.

Probetyla subaptera sp. nov.

♀. Length 2.2 mm. Uniform yellowish brown, the legs paler than the body. Head, seen from above, but little wider than thick, the eyes set at the anterior corners, about two-thirds as long as the temples which are suddenly narrowed behind; occiput margined; seen from the side, the head is high as long, the frontal projection rather small; face nearly horizontal, the eyes more than their own length from the base of the mandibles; surface of entire head smooth. Antennæ but slightly thickened apically; scape as long as three following joints taken together; thicker near the middle, not spinose at apex; pedicel twice as long as thick; first flagellar joint longer and more slender, three times as long as thick; second to sixth gradually shorter and thicker, four following moniliform, each about one-half wider than the first flagellar joint. Pronotum short medially, but distinctly visible from the above; mesonotum as long as broad, with a deep groove next its anterior margin extending from tegula to tegula; parapsidal furrows complete, nearly parallel. Scutellum with two large, narrowly separated foveæ at base. Upper surface of propodeum nearly horizontal, convex. Pro- and mesopleuræ smooth and shining; metapleura finely rugose and densely pubescent. Petiole finely longitudinally aciculate; two-fifths as wide as the propodeum; gaster one-half wider than the thorax and as wide as the head.

Type from Nelson, New Zealand, December 8, 1921 (A. Philpott).

Parabetyla gen. nov.

♀. Entirely wingless. Head, thorax and petiole narrow; gaster broad. Head with a very prominent frontal projection, longer than wide; eyes small, with a few long hairs; ocelli absent. Antennæ 15-jointed, with a stout 6-jointed club. Maxillary palpi 5-jointed; basal joint minute; apical one much longer than the others. Thorax much elongated; pronotum medially half as long as at the sides; mesonotum small; scutellum without basal impressions, half as long as the mesonotum; propodeum separated by a constriction basally above; apically with three long thorn-like spines, one median and another at each side. Petiole twice as long as thick, without tooth below. Gaster large, elongate oval, composed almost entirely of the second segment. Legs stout, the femora very strongly clavate, but the tibiæ not noticeably so. Body clothed with nearly erect sparse pale hairs..

Type: *Parabetyla spinosa* sp. nov.

Parabetyla spinosa sp. nov.

♀. Length 3.3 mm. Entirely rufo-ferruginous, the abdomen and antennæ slightly paler. Head, seen from above, one-third longer than wide, including the frontal projection; widest at the eyes which are near the middle, obliquely narrowed anteriorly to the base of the antennal projection, rounded behind, the occipital margin strongly and conspicuously carinate. Head seen from the side sub-triangular, the face long, straight; front above highly convex; eyes their own diameter from the frontal projection and three times as far from the mandibles; entire surface smooth and shining. Antennal scape as long as the head, thickest basally, as long as the seven following joints together; pedicel twice as long as thick, slightly longer and stouter than the first flagellar joint; three following of equal length, becoming moniliform; fifth, sixth and seventh larger; beyond this the joints become large, forming a very gradual but stout club, of which the joints except the last are barely wider than long. Pronotum slightly projecting at its humeral angles, twice as long as the mesonotum at the sides; the mesonotum separated by a deep grooved line, no longer than the portion of the pronotum visible medially; scutellum large, as broad as the mesonotum, the basal suture not impressed nor foveate. Propodeum very short, twice as high as long, its spines curve backwards, with the median one set somewhat forward of the lateral ones. Pro-and mesopleuræ smooth and polished; metapleura and sides of propodeum rugose, with several more or less regular oblique carinæ extending downwards and backwards. Petiole finely longitudinally rugose-striate, narrower at base and apex. Gaster about three times as broad as the head or thorax. The hairs on the body are denser on the petiole, propodeum and base of abdomen, and entirely absent on the pro- and mesopleuræ. Tarsal claws stout, simple; tibial spurs minute; hairs on femora very sparse, those of the tibiæ conspicuous.

Type from Dun Mountain, New Zealand, at an altitude of 2000 feet, March 15, 1921 (A. Philpott).

THE EUROPEAN HOUSE CRICKET; HEARTH CRICKET.

By A. P. Morse, Peabody Museum of Salem.

This cricket, in the winter of 1920, became a nuisance in a dwelling at Swampscott, Mass., damaging clothing in the basement laundry and annoying by its persistent chirping (recorded in my manual of N. E. Orth., p. 393), but shortly after disappeared and is not now found there.

On Oct. 16, 1922, I captured an adult male in an open pasture at Marblehead, Mass., several miles away. No others were seen. Curiously enough, in connection with the fireside association of the species, tho probably without definite significance, this specimen was found hiding under a fragment of partly burned board lying on the charcoal of an old bon-fire site.

NOTES ON *LIVIA MACULIPENNIS* (FITCH) (HOMOPTERA; CHERMIDÆ)

By Harry B. Weiss and Erdman West

Highland Park, N. J.

This jumping plant louse which is recorded by Van Duzee[1], as occurring in Quebec, New Hampshire, New York, Massachusetts New Jersey, Pennsylvania, District of Columbia and Alabama has been known for some time to be associated with the elongate gall on rush (*Juncus* sp.), the floral parts being aborted, the bracts of the inflorescence increasing to many times their normal size and forming closely imbricated clusters from 3 to 4 cm., in length. For several years this species has been noted at Monmouth Junction, N. J., and the following notes have been accumulated.

The adult overwinters and appears during the middle and last of May. The oval, lemon-yellow eggs are deposited in rows on the inflorescence and bracts, each egg being fastened on the plant tissue by means of a short, backward projecting, basal stipe. A few eggs were found as late as June 17 after the galls were fully developed and these occurred on the inner surface of the lowest bract. After hatching the nymphs make their way to between the folded leaf-like parts, most of them feeding head downward between the sheaths. By the last week of June many are fully developed and the first adults emerge several days later. Most of the nymphs inhabit the outer sheaths and only a few are found in the tightly rolled inner sheaths. Some galls were found to contain from 25 to 100 nymphs. Those with fifty or more were quite swollen. The larger nymphs have the ends of their abdomens clothed loosely in waxy threads. As a rule nearly all nymphal stages can be found in a gall during the last of June, with the possible exceptions of newly hatched ones. Based on size and structure, the nymphs were easily arranged into five stages and the following descriptions indicate the development which takes place from egg to adult.

[1] Van Duzee, Cat. Hemip. Amer. North of Mexico.

EGG. Length, 0.3 mm. Greatest width 0.9 mm. Lemon yellowish; elliptical, somewhat flattened on one side, bluntly pointed at distal end, basal end terminating in a short projecting stipe. First Nymphal Stage Length 0.4-0.45 mm. Width of head across eyes, 0.12 mm. Color, pale yellowish or whitish tinged with brown. General shape, subrectangular, somewhat flattened. Head truncate, slightly narrower than thorax; eyes red, lateral; antennæ erect, cone-shaped, tip truncate and bearing two hairs. Thorax with sides subparallel, slightly converging posteriorly, length about one-third greater than length of abdomen, segmentation indistinct. Abdomen subcircular to oval except where it joins the thorax, segmentation indistinct, fringed with a row of equidistant hairs. Sheath of rostrum extending almost to between second pair of legs. Legs short, chunky, gradually tapering toward tip which bears a sucker disk and two hairs.

Second Nymphal Stage. Length about 0.73 mm. Width of head across eyes 0.22 mm. similar to preceding stage in color, shape and general proportions.

Third Nymphal Stage. Length about 1.1 mm. Width of head across eyes, 0.3 mm. Color, shape and general proportions somewhat similar to those of preceding stage. Dorsal surface of thorax bears brownish spots. Upper surface of last few abdominal segments brownish. Tips of legs and tips of antennæ brownish. Sides of mesothorax produced laterally into pronounced pads. Sides of metathorax produced laterally into pads less pronounced than those of mesothorax. Abdomen about as long as thorax, more oval in shape than formerly and with a more decided yellowish tinge, tip clothed with many fine hairs. Fourth Nymphal Stage. Length about 1.7 mm. Width of head across eyes 0.5 mm. Yellowish white. Head as wide as thorax broadly rounded anteriorly. Eyes, red, prominent, lateral.

Antennæ conical, erect, as long as width of head between antennæ. Thorax subrectangular, about as long as abdomen, sides parallel, dorsal surface bearing several brownish spots. Wing pads large, pronounced extending obliquely, posteriorly. Wing pads bearing few short hairs. Abdomen oval, constricted somewhat anteriorly, strongly convex, segmentation indistinct, apical segments covered dorsally by a somewhat chitinous plate, tip and sides sparsely clothed with short hairs. Legs chunky. Sheath of rostrum extending to between first and second pairs of legs.

Fifth Nymphal Stage. Length about 2.5 mm. Width of head across eyes, 0.6 mm. Color pale or dirty yellowish tinged with brown. Tips of antennæ, tips of legs and edges of wing pads somewhat brownish. Ventral surface pale. Head and thorax subequal in width. Eyes, lateral, prominent, red. Head and almost all of dorsal surface of first thoracic segment except for a broad, median line on head and thorax covered by a light brownish chitinous area. Prothorax two-thirds as long as mesothorax. Metathorax slightly less than one-half as long as prothorax. Wing pads of mesothorax extending to beginning of first abdominal segment. Wing pads of metathorax extending almost to end of second abdominal segment. Dorsal surface of mesothorax bearing a small, brown area and a dot on the anterior margin each side of a median line; on posterior margin a large brown area and three closely placed darker spots or dots on each side of median line. Metathorax bears dorsal areas and spots similar to those of mesothorax. Anterior edge of first abdominal segment bears areas and spots similar to those on anterior edge of metathorax. Abdomen subcircular, strongly convex. First segment narrowed, gradually widening to fourth and then narrowing to broadly rounded extremity. First six abdominal segments distinct, remainder fused and covered with a darker, dorsal, chitinous plate; a tubercular, process on each side of anal opening. Sides and tip of abdomen bearing short hairs Dorsal surface of abdomen has a velvety appearance. Antennæ, head, wing pads and legs bearing several short hairs.
Adult. This was described by Fitch in 1857 (Ann. Rept. N. Y. State Agric. Soc. XVII, p. 740) from specimens collected during the middle of May in extensive tracts of sweet flag (*Acorus Calamus*) growing on the banks of the Raritan River two miles below New Brunswick, N. J. His description follows.

"Spotted winged Diraphia, *Diraphia maculipennis* N. sp.

This is a smaller species, measuring but 0.10 to the tips of its wings, and is tawny red, with the thorax tinged more or less with dusky, the antennæ with a broad black band towards their tips, the anterior wings more short and broad than in any of the other species, and hyaline with a broad smoky brown band on their tips, a spot back of the shoulder and some freckles near the margin also smoky brown, the veins, including the marginal, all white alternated with numerous black rings, the breast and hind breast blackish and the legs dusky brown tinged more or less with tawny yellow."

Miss Edith M. Patch has referred to this species several times and these references can be found in Van Duzee's catalogue. In *Pysche* (vol. XIX, p. 6,1912) Miss Patch places Provancher's *Livia bifasciata* as a synonym of *maculipennis.*

This insect which has commonly been known as the sedge psyllid has for its most conspicuous host a *Juncus* which is a plant belonging not to the "sedges" but to the "rushes", hence it might be called more correctly. the rush psyllid.

HEMIPTEROLOGICAL NOTES[1].

By Roland F. Hussey, Forest Hills, Mass.

I.

During the summers of 1920, 1921, 1922, I found a very agile species of Orthotylus abundant on the hollyhocks in the grounds of the University Observatory at Ann Arbor, Michigan. From June until late September, at least, adults and nymphs were numerous, occurring on the *upper* side of the leaves, and the plants showed plainly the effect of their work. At the time when I first collected this form, I was unable to identify it with any described species of the genus, but subsequently I discovered a description which applies perfectly to the specimens before me. This description appears to have been overlooked, and is not listed in Van Duzee's catalogue.

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[1] Contribution from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 214.

In 1891, A. J. Cook[2] gave an account of the hollyhock bug, and described and figured the species under the name "*Orthotylus* (*Psallus*) *delicatus* Uhler[3]." His description is quite ample for recognition of the species; and, inasmuch as the name he employs is merely one of Uhler's manuscript designations, the species must be known as *Orthotylus delicatus* Cook. Heidemann[4] also records an *Orthotylus delicatus* Uhler MS, from the District of Columbia; but since his form occurred only on ash trees, while Cook's species, in my experience, is confined to hollyhocks, I doubt the identity of the two.

That the specimens taken by me at Ann Arbor belong to Cook's species is confirmed by examination of the specimens standing in the collection of the Michigan Agricultural College under the name *Orthotylus delicatus* Uhler, which Professor R. H. Pettit has kindly forwarded to me. Only two of these specimens were collected prior to the date of Cook's description, and I have therefore designated one of these as the lectotype of the species. The following redescription is drawn up from fresh material.

Orthotylus delicatus Cook.—Oblong-oval; green, the membrane smoky with the veins calloused, greenish or whitish; body sparsely clothed with white hairs, the dorsal parts also with short, thick, closely appressed black hairs. Length, 3½ mm.

Head, with the eyes, very nearly ¾ as wide as the pronotum at base, and about twice as wide as long (in dorsal aspect); basal carina low and inconspicuous, vertex broadly flattened; clypeus, seen in profile, projecting beyond the frons by nearly the thickness of the basal antennal segment. Eyes occupying about one-half (19/36) of the vertical height of the head. Antennæ

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[2] Bull. 76, Mich. Agr. Coll. Exper. Sta. p. 10. This bulletin is entitled "Kerosene Emulsions."

[3] This is not the *Psallus delicatus* Uhler 1887, described in Ent. Amer. iii, p. 34.

[4] Proc. Ent. Soc. Wash., ii. 1892, p. 226.

inserted near the lower angles of the eyes, yellowish or greenish, the fourth and sometimes the apical half of the third segments infuscated; all segments with short appressed hairs; ratio of lengths of segments, 20:77:68:32, the basal segment as long as the dorsal aspect of the head, the second segment about one-fourth longer than the basal width of the pronotum. Rostrum yellow, its apex piceous, reaching onto the middle coxæ. *Pronotum* transverse, twice as wide as long, the lateral margins very lightly sinuate, the anterior angles broadly rounded; callosities distinct, joined anteriorly by a transverse elevation behind which are a pair of deeply impressed punctures; disk rather flat, the lateral submargin broadly impressed; anterior angles with a long seta directed obliquely outward and forward. *Hemelytra* rather short, the abdomen reaching to the middle of the cuneus (♂) or somewhat beyond its apex (♀). Male genital claspers (Fig. 1) distinctive of the species.

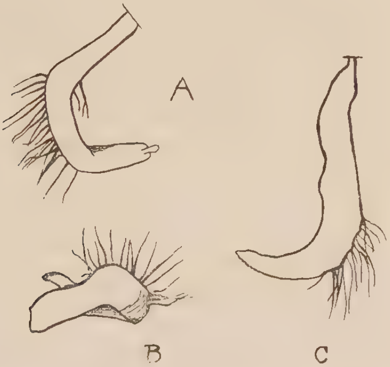

Fig. 1. Male genital claspers of *Orthotylus delicatus* Cook. A, right clasper, dorsal aspect; B, right clasper, lateral aspect; C, left clasper, dorsal aspect.

Color: dorsal parts green in fresh specimens, fading after death to yellow on head, pronotum anteriorly, and scutellum; pectus and venter greenish or yellowish; membrane smoky, the smaller areole and a small rounded spot next to the cuneus hyaline, the veins calloused, greenish, becoming white at the apex of the larger cell. Legs yellowish; tibiæ piceous at the extreme apex, the fore and middle tibiæ often greenish on the apical half; third segment of tarsi, often also the base of the first segment, piceous. Body rather sparsely clothed with white hairs, most conspicuous on the lateral margins of pronotum and hemelytra; dorsal parts (including head) also with conspicuous short black hairs which are flattened and deciduous.

Orthotylus (*Psallus*) *delicatus* Cook, 1891, Bull. 76, Mich. Agr. Coll. Exper. Sta., p. 10, fig. 1 (manuscript name of Uhler).

This species is readily distinguished from the other American representatives of the genus Orthotylus by the character of the vestiture and the genital claspers.

Redescribed from numerous specimens collected at Ann Arbor, Mich., June to September, 1920, 1921, 1922. I have also seen individuals from Stockbridge, Mich., 1-IX-1920 (R. F. Hussey); Battle Creek, Mich., 18-VI-1922 (Priscilla Butler); and four from East Lansing, Mich., bearing the label "Ag. Coll. Mich." Lectotype, ♀, "Ag. Coll. Mich. 7-29-'90. 1642.", in collection of the Michigan Agricultural College.

II.

In my recent paper on Hemiptera from North Dakota[5], there are two errors which require correction.

p. 9, line 27. In place of *Ischnodemus falicus* (Say), read *Ischnodemus hesperius* Parshley (1922, Bull. Brookl. Ent Soc., xvii, p. 123, =*I. brevicornis* Parshley, 1922, S. Dak. State College Techn. Bull. No. 2, p. 8; name preoccupied).

p. 10, line 28. In place of *Peritrechus fraternus* Uhler, read *Peritrechus saskatchewanensis* Barber (1918, Jl. N. Y. Ent. Soc., xxvi, p. 60).

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[5] Occas. Papers Mus. Zool. Univ. Mich., No. 115, July 1, 1922.

III.

Dr. Bergroth has kindly called to my attention a reference which was omitted from my bibliographical notice on the Reduviid genus Triatoma[6]. In their "Textbook of Medical Entomology," Patton and Cragg (1913) give figures of *T. rubrofasciata* (Pl. LIX, fig. 1) and *T. megista* (Pl. LIX, fig. 2), of the eggs and nymphs of *T. rubrofasciata* (Pl. LX, fig. 2, 3, 5, 7), and some of the anatomical details of *T. rubrofasciata* (Pl. LXII, figs. 1, a, 1b, 5, 8, 10). They also give translations of Neiva's descriptions of some of his species, as follows;

p. 492. *T. mexicana* Neiva (as var. of *rubrofasciata*),

p. 494. *T. sanguisuga ambigua* Neiva, *T. uhleri* Neiva. *T. neotomae* Neiva.

p. 495. *T. brasiliensis* Neiva, *T. flavida* Neiva, *T. heidemanni* Neiva, *T. occulata* [sic] Neiva.

Descriptions are also given of *T. rubrofasciata* (p. 487), *T. megista* (p. 492), and *T. sanguisuga* (p. 493); and the bionomics of the genus are well treated (pp. 488-493). Throughout this treatment, Patton and Cragg use the name *Conorhinus* for the genus.

IV.

Stenopoda cinerea Laporte. This species was first described by Fabricius (1775) under the name *Cimex culiciformis*, and is antedated by *Cimex culiciformis* DeGeer (1773), a species now placed in the genus Ploiariodes. Laporte's name is the next availiable designation for the Fabrician species.

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[6] Psyche, xxix, 1922, pp. 109-123.

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SUPPLEMENT TO PSYCHE
VOLUME 29, OCTOBER-DECEMBER, 1922.

ODONATE LARVÆ OF NEW ENGLAND.

BY R. HEBER HOWE, JR.

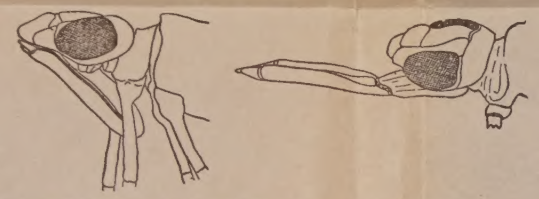
THE accompanying pictorial key which will be published also in the author's "Manual of the Odonata of New England" (Mem. Thoreau Mus. Nat. Hist., II: Nymphs, Part 2.) it is hoped will arouse an interest in the study of the larvæ of these interesting insects. For the use of two diagrams, I am indebted to Mr. C. B. Wilson and the Bureau of Fisheries. I shall be glad to receive for study and determination larvæ collected in new England.

EDITOR'S NOTE. This is the second one of Dr. Howe's charts to be distributed with PSYCHE. The first, relating to Zygoptera, was included in the issue for October, 1918 (Vol. 25, No. 5).

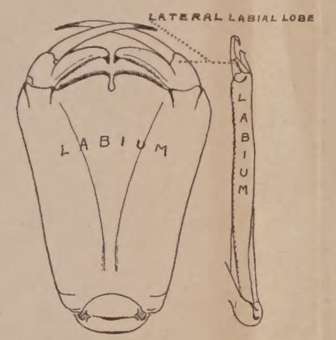
PICTORIAL KEY TO ANISOPTERAN NYMPHS OR LARVAE

ANISOPTERA

AESCHNIDAE (excluding CORDULEGASTERINAE)

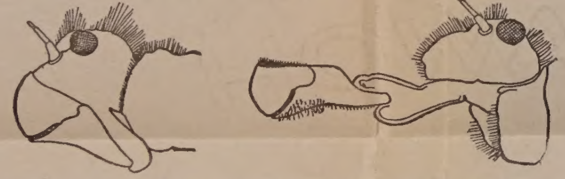


Showing *flat* labium *closed*, *not* hiding face. Labium *extended*

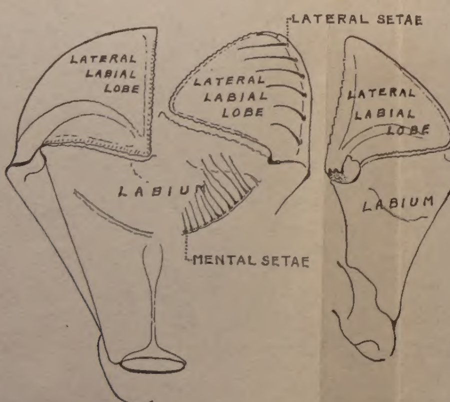


Labium *flat*, *without* raptorial (= lateral and mental) setæ

LIBELLULIDAE (including CORDULEGASTERINAE)

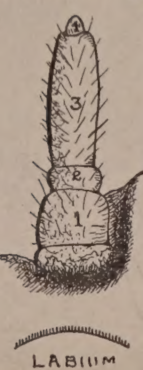


Showing *spoon-shaped* labium *closed*, *hiding* face. Labium *extended*



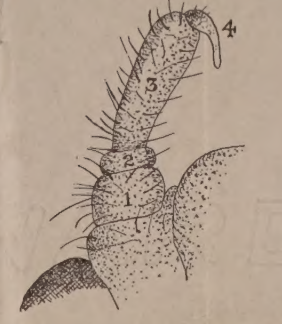
Labium *spoon-shaped*, *with* raptorial (= lateral and mental) setæ (see Key to LIBELLULIDAE)

GOMPHINAE. Burrowing Larvae

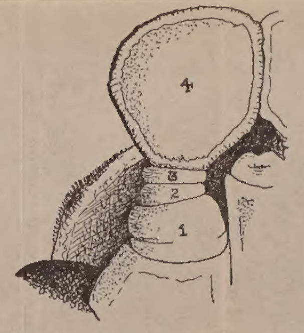


Antenna *four* jointed. Labium with medium lobe *uncleft* (= entire)

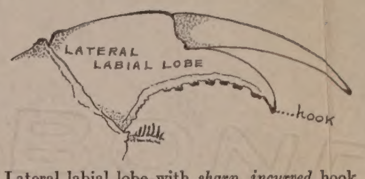
PROGOMPHUS



Terminal (4th) segment of antenna *recurved*, *slender*, as *long* as third segment is wide

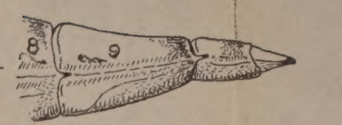


Terminal (4th) segment of antenna orbicular or discoid, or rudimentary when much *shorter* than third segment is wide (see figure under GOMPHINAE)



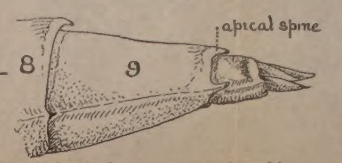
Lateral labial lobe with *sharp*, *incurved* hook at apex, or at least *never* rounded at apex

GOMPHUS

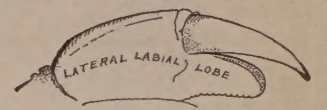


Abdominal segments 8 and 9 *without* or with only a *rudimentary* apical spine

DROMOGOMPHUS

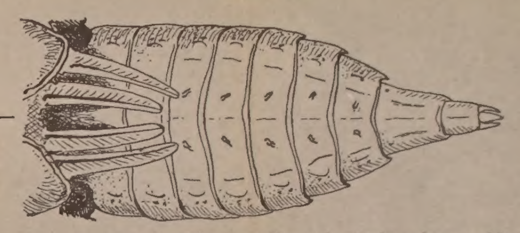


Abdominal segments 8 and 9 *with prominent* apical spine



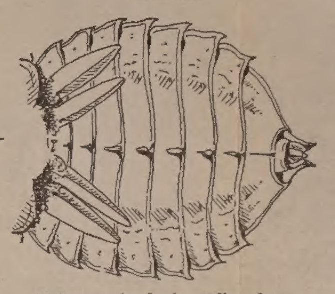
Lateral labial lobe *rounded* at apex

OPHIOGOMPHUS



Abdomen *ovate* or *lanceolate* in outline at *least twice* as *long* as wide

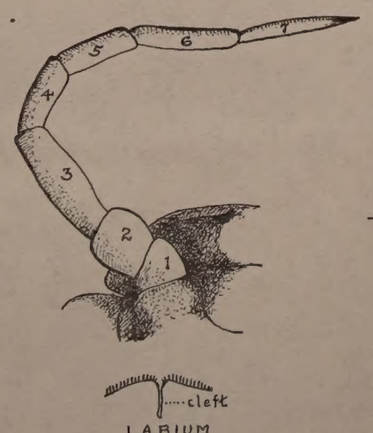
HAGENIUS



Abdomen *circular* in outline almost as *wide* as *long*

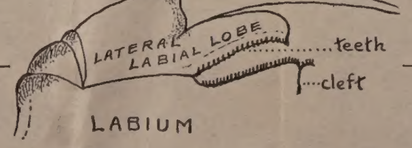
GOMPHAESCHNA. Mature larva unknown

PETALURINAE. Mud-loving Larvae
AESCHINAE. Climbing Larvae



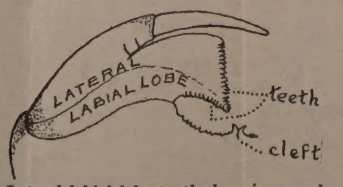
Antenna *seven* jointed. Labium with medium lobe *cleft*

AESCHINAE

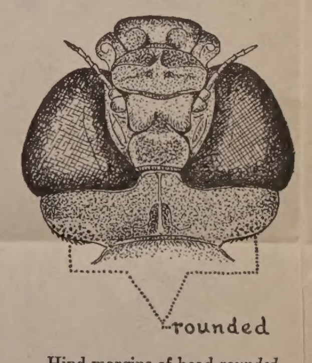


Lateral labial lobe toothed *only* on *inner* margin
Antennae *slender*

PETALURINAE
TACHYOPTERYX

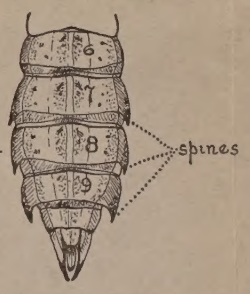


Lateral labial lobe toothed on *inner* and *terminal* margins. Antennae *stout*

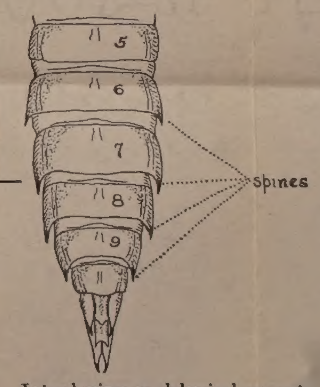


Hind margins of head *rounded* or *subangular*

ANAX

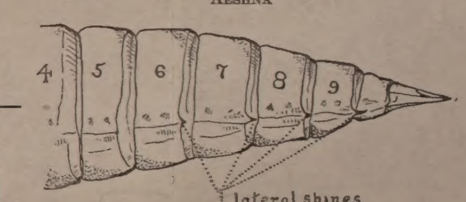


Lateral spines *only* on abdominal segments *seven* to nine



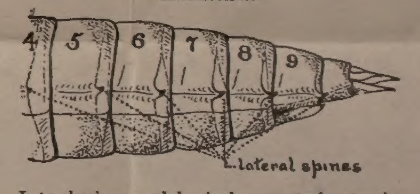
Lateral spines on abdominal segments *four*, *five* or *six* to nine

AESHNA

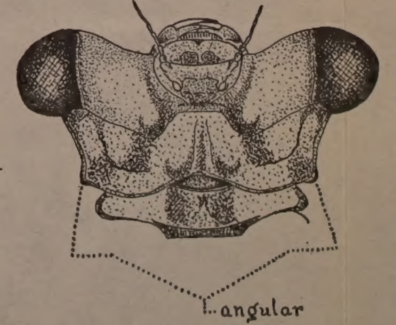


Lateral spines on abdominal segments *five* or *six* to nine

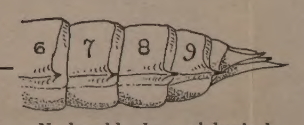
EPIAESCHNA



Lateral spines on abdominal segments *four* to nine

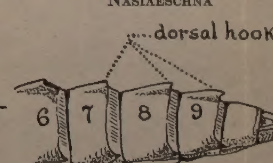


Hind margins of head *acutely angular*



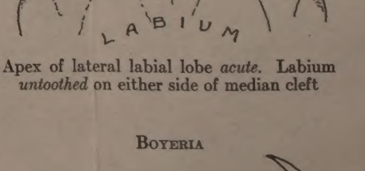
No dorsal hooks on abdominal segments

NASIAESCHNA



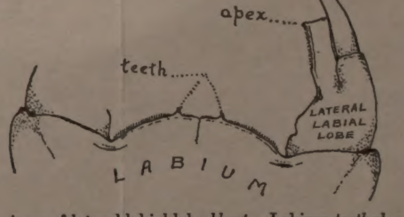
Dorsal hooks on abdominal segments seven to nine

BASIAESCHNA



Apex of lateral labial lobe *acute*. Labium *untoothed* on either side of median cleft

BOYERIA



Apex of lateral labial lobe *blunt*. Labium *toothed* on either side of median cleft

NOTE The antennae of Epiaeschna, contrary to the condition implied in the above key, have SIX joints, instead of SEVEN This fact in no way injures the value of the key, although the caption should read "SIX or SEVEN segments" in the Aeschninae, as compared with FOUR in the Gomphinae This antennal condition, however, proves to be the best morphological character, as NO lateral spines have been found on abdominal segment FOUR in seven specimens recently examined. Cabot stated - MEMOIR M C. Z., 8: 31, 1881 - in his description that spines were present on segment FOUR, and this has been used by Needham and others as the best generic character, and was used by the author in the preparation of his key; but neither Cabot's specimen, from which his figure was made, nor his figure - ibid., Pl. I. fig 3 - have spines on this segment The best morphological character, therefore, to separate full-grown larvae of Aeschna and Epiaeschna is that in the former the antennae are SEVEN jointed, in the latter SIX Mature larvae of the former never measure over 40 mm.; the latter under 45 mm.

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